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IN-SITU PENETRATION TESTS IN A PLEISTOCENE ALLUVIUM NEAR CAIRO

ESSAIS DE PENETRATION IN-SITU DANS UNE ALLUVION DU PLEISTOCENE AUX ENVIRONS DE CAIRE

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SYNOPSIS : The purpose of this paper was to study the in-situ tests in alluviums deposited during the Pleistocene as a result of filling inbetween a once river Nile meander. A frequent situation in several sites along the Nile valley in Egypt. A site 25.00 km south of Cairo city centre was chosen in which a large building project was constructed. In-situ tests were the Standard Penetration Tests (SPT) and the Dutch Static Cone Tests (CPT) being the most widely used field tests worldwide. Special interest was made to the upper 10.00 m of the site. The SPT were made by three different companies at almost the same locations. The lithology of the chosen site was such that the top strata were mainly granular with low strengths and precarious structures. General trends and patterns of results were compatible. Discrepancies in SPT results indicated the sensitivity to changes in procedure or equipment. In general CPT gave a more accurate indications to the bearing capacities of different strata. Relationships between SPT and CPT were studied for use in sites of similar geological formation.

LOCATION OF THE SITE

The site lies in Masara some 25.00 Km south of Cairo city centre east of the river Nile and nearer to the suberb of Helwan. It was initially an orchard when purchased by the owners.

SITE INVESTIGATIONS

Extensive number of boreholes were drilled. SPT were carried out in every borehole. Ten CPT were also carried out. Different companies did the work. Namely three.

Laboratory testing programme was carried out to obtain full data for the foundation design. The upper granular strata were thoroughly studied. As for cohesive layers at these upper strata (1.00 m to 5.00 m) they were clays of low plasticity (CL) or silts of low compressibility (ML) or both.

For these soils the Liquid Limits (LL) were about 31.00% and the Plastic Limits (PL) 22.25% on the average. Their dry densities were 1.63 T/cu m and Specific Gravities (Gs) 2.71. In the oedometer the coefficient of consolidation Cv was :

$$Cv = 24.00\ cm^2/sec \times 10^{-4} \text{ at } 2.00\ Kg/cm^2.$$

Their compressibility Index Cc = 0.55.

Deeper cohesive layers had an average LL of 21.00% and no PL were obtainable. Their natural water contents Wn were 21.00% and were classified as silty sands (SM).

Water salinity as NaCl was 772.00 ppm and sulphates in the form of SO_3 were 312.00 ppm. As for soils their salinities were NaCl 0.17% to 0.30% and their SO_3 from 0.29% to 0.44%.

SPT were carried out in the final investigation under the direct supervision of the auther. Previous SPT and CPT were reported . CPT were done using 20.00 Tonnes Furgo machine following strictly the required specifications.

GEOLOGY OF THE SITE

The river Nile valley was cut in Egypt during the Miocene (Himdan 1980, Said 1981 and Said 1993). It had a more meandering course during the Pliocene than the Quaternary. During the Pliostocene several of these meanders were filled up by meander-built depositsoverlying infill deposits. (Brown 1984, Mclean and Gribble 1979 and Sowers 1979).

At the site Pliocene deposits boarders the agricultural zone or belt of the Nile valley and they - in turn - rest on the edges of the Eocene. (Himdan 1980 and Mowafy and El Ghamrawy 1988).

The formation of the recent deposits must have taken place during the Pleistocene resulting in a more "straight" course for the Nile at this location and northwards to Cairo. Old Meanders became just gentle curves.

The top strata have characteristics typical of those of fluvial domain . (Sowers 1979)

1) They are erratic deposits of silty sands and gravels and irrigular inticular masses of cohesive matters. These cohesive alluviums lie to the left of the "Casagrands's A-line" in soil classification.
2) Their textural range is high.
3) They are most likely hetrogeneous. Channel sands and cut and fill structures are common.
4) These valley fill fluviums are usually loose and may be cemented by continuing weathering and precipitation of soluble salts. They are apt to collapse upon wetting.
5) Ground water tables were at a depth of about 3.00m from the average zero level of the site.

SPT AND CPT RESULTS

SPT were carried out at every borehole location. Three stages (D,M and V) of investigations were carried out.

at moreorless the same locations. Ten CPT were done scattered allover the site.

Fig.(1) and Fig.(2) show examples of comparative results of SPT at moreorless the same spots but during different investigations. During all investigations the site was still virgin and has undergone no disturbance whatsoever.

Fig.(3) and Fig.(4) show typical CPT results of the site. Fig.(5) show several relationships. It shows logs of two boreholes M1 and M2 with their N values. It also shows the CPT results of tests 2, 2a and 6 which were at adjacent locations to boreholes M1 and M2. In fig.(5) the ratios n of the CPT resistance qc Kg/sq.cm and the number of blows N of the SPT are plotted for eight of the ten CPT and their adjacent SPT.

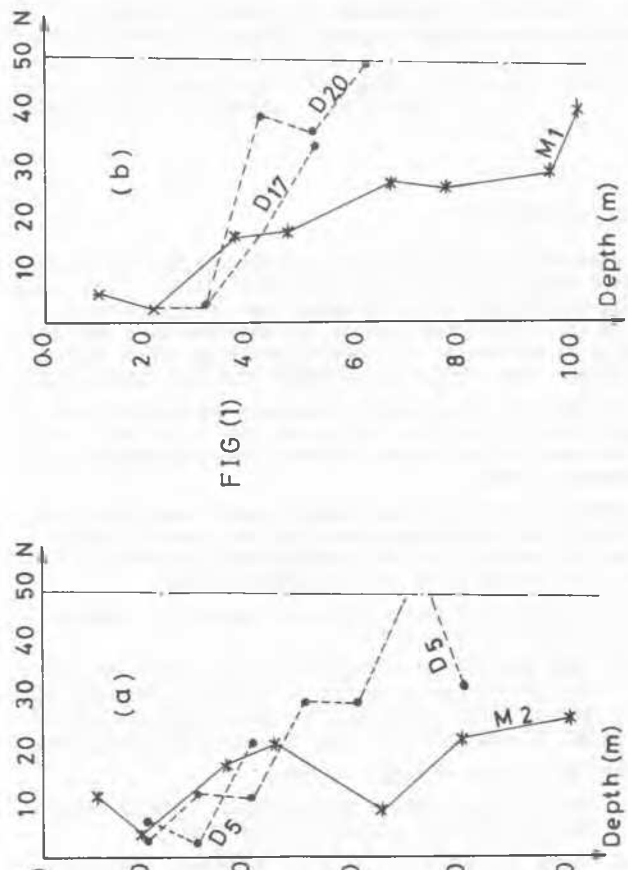
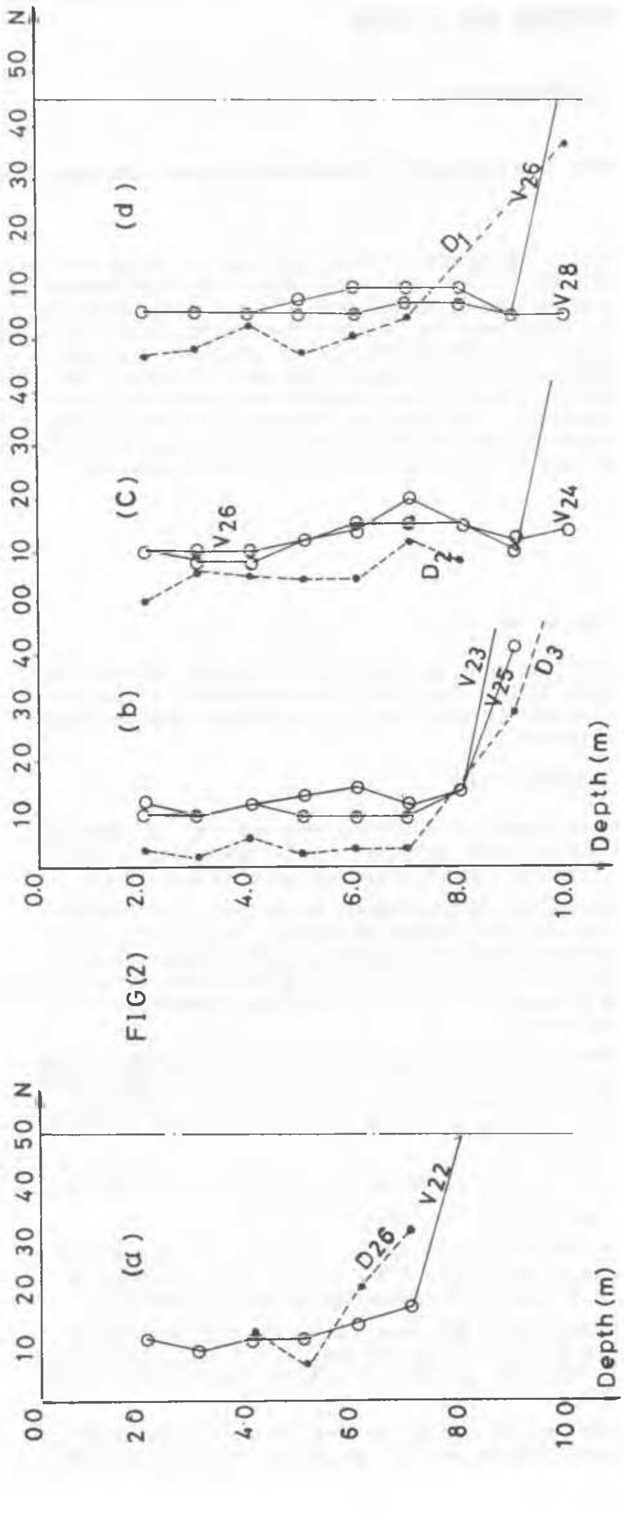


FIG (1)



FIG(2)

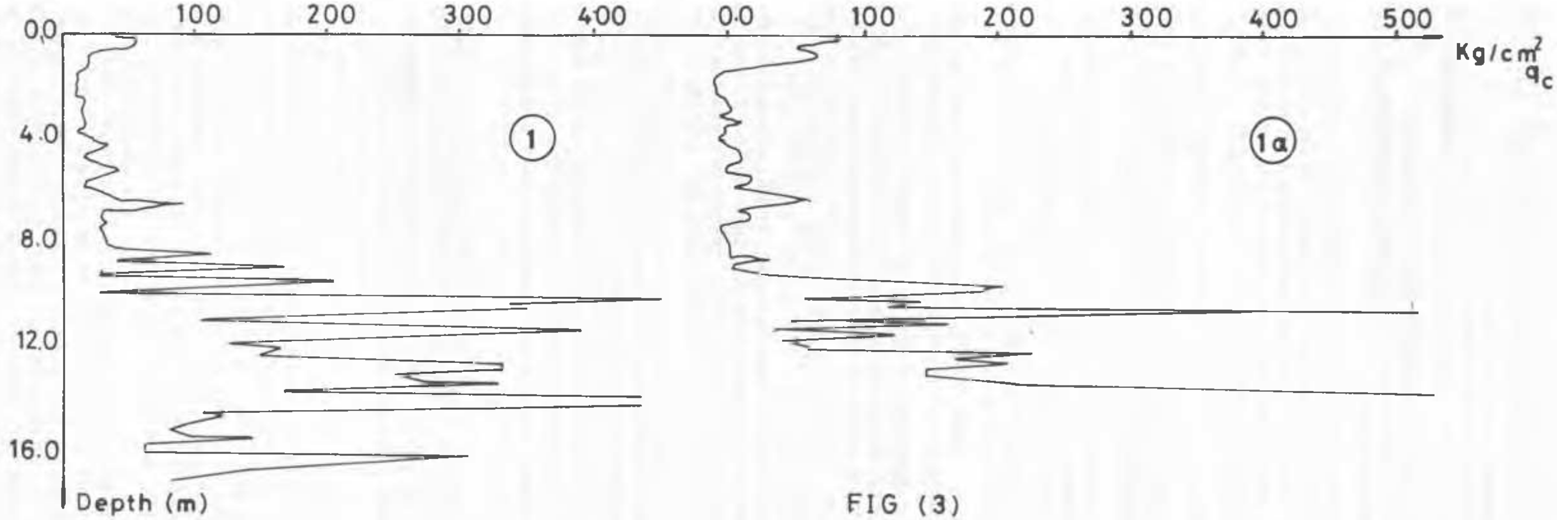
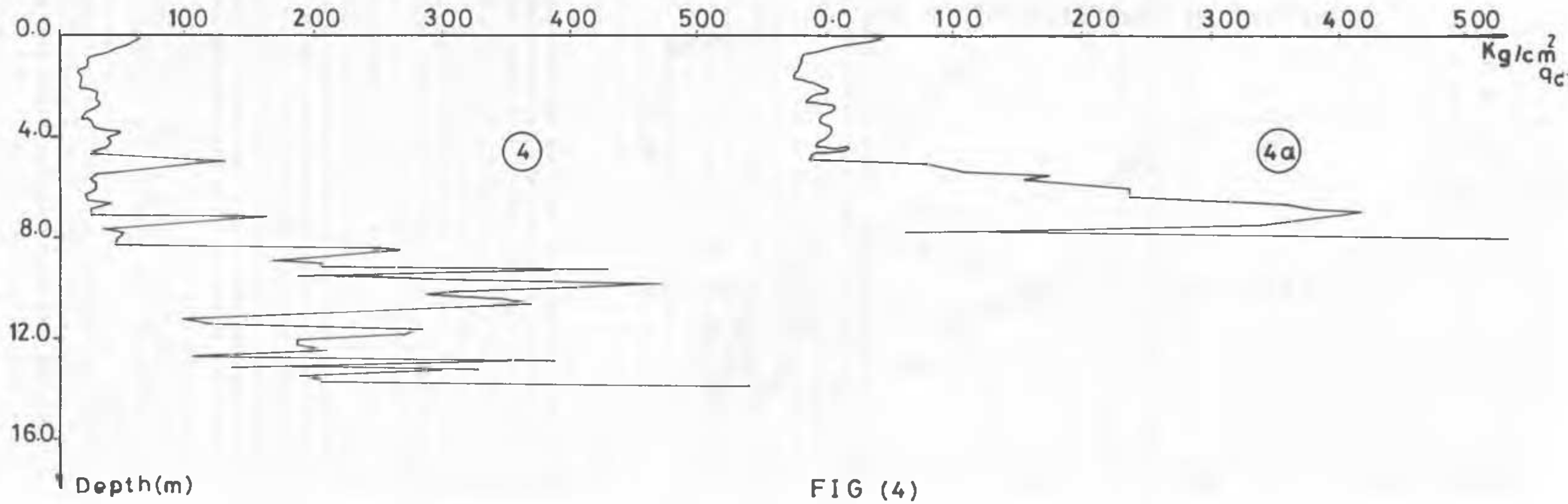

0.0
100
200
300
400
0.0
100
200
300
400
500
Kg/cm²
q_c
4.0
8.0
12.0
16.0
1
1a
Depth (m)

FIG (3)


0.0
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0.0
100
200
300
400
500
Kg/cm²
q_c
4.0
8.0
12.0
16.0
4
4a
Depth(m)

FIG (4)

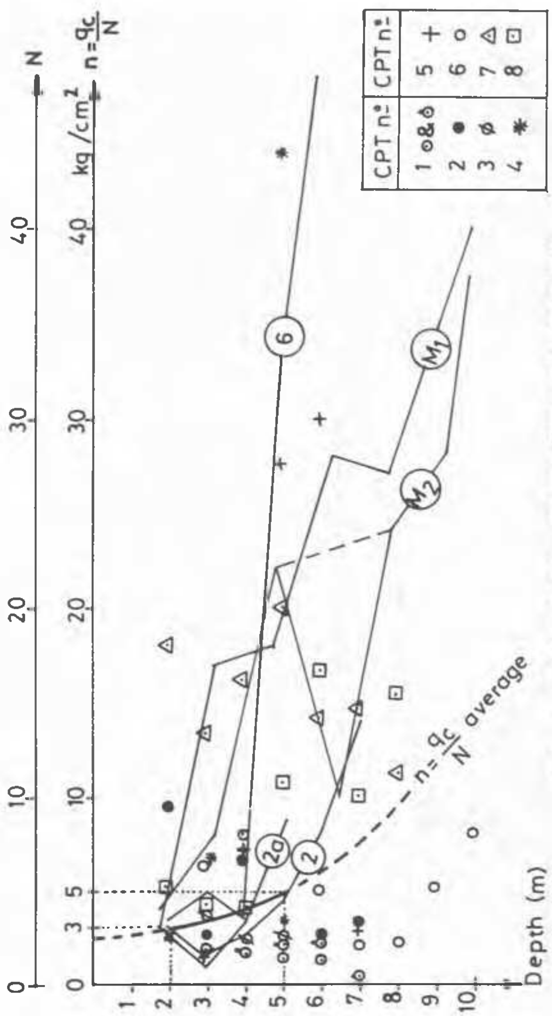

FIG. 5 CORRELATIONS BETWEEN CPT & ADJACENT SPT

ANALYSIS OF RESULTS

The purpose of this research was to study the behaviour of meander-built deposits (MBD) as foundation materials and compare this behaviour with that of soils with similar constitution but different geological histories. Most of the MBD were sands and silty sands with little gravel. Silty clays were also found. It was apparent that these deposits had more erratic formations than similar soils with different depositional circumstances.

The effect of these erratic formations were more pronounced in dynamic SPT than in static CPT where their measurements showed steadiness and less erratic behaviour. Also this lead to different stiffnesses, anisotropies.etc. (Lunne et al 1989 and Decount 1989). Thus the ratio n between qc Kg/sq cm and N (n = qc/N) differed from priviouxly reported values in similar soils but with different histories.(Nixon 1982, Kruizinga 1982 and Sanglerat 1979).

In this study n ranged from 3 at a level of 2.00 m to 5 at 5.00 m. This is important since n should hold almost the same value within the same stratum. But in MBD it increased with depth.

Slight differences in technique between the three companies that did the SPT lead to differing N. These differences were in robes and number of robe turns over the cathead.

CONCLUSIONS

1- MBD are mainly granular of precarious structures and erratic formations. Only in-situ testing can give realistic data for foundations. MBD differ in behaviour from similar soils with different histories.

2- CPT results were more consitent that SPT. CPT is the recommended test for MBD. The ratio n = qc/N increased with depth in MBD within the same stratum. In other soils it holds almost the same value throughout.

3- Even slight - sometimes taken for granted - differences in SPT technique affect their measurement to a considerable degree.

4- Use of MBD as foundation materials is bettered by bringing their structures into more stable state. Their shear strengths are best measured and monitored in the field and by the CPT. The ratio n can be used only if SPT were also recorded.

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